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A comparative analysis of postoperative morbidity and alveolar bone regeneration following surgical extraction of ımpacted lower third molar teeth using piezosurgery and conventional ınstruments: a split-mouth clinical ınvestigation

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Abstract

Background-objective(s) This randomized, split-mouth study aimed to compare postoperative complications following the surgical extraction of impacted lower third molars using piezosurgery versus conventional rotary instruments.

Materials and methods Twenty-one patients, aged 18–35 years, with bilaterally and symmetrically impacted lower third molars, were randomly assigned to undergo extraction using piezosurgery on one side and conventional rotary instruments on the other.

Results The piezosurgery method required a longer operation time. However, it resulted in quicker resolution of postoperative swelling by the 7th day compared to the conventional method, where swelling persisted longer. Mandibular angle-tragus measurements were significantly higher with the conventional method on the 1st, 3rd, and 7th postoperative days. Although mouth opening decreased significantly after piezosurgery, it returned to preoperative levels by the 7th day, outperforming the conventional method. Postoperative pain was notably higher with the conventional method during the first four days but showed no significant difference from the 5th day onward. Alveolar bone healing was significantly better with piezosurgery at the 3rd and 6th months. Temporary paresthesia occurred in one patient from the conventional group, resolving within four weeks. Neither method resulted in alveolar osteitis.

Conclusion(s) Within the study's limitations, piezosurgery demonstrated a reduction in postoperative discomfort, suggesting its advantage in enhancing patient recovery following lower third molar extractions.

Clinical significance Piezosurgery, when used appropriately, can reduce postoperative complications compared to conventional methods. Clinicians should be aware of its indications, benefits, and potential challenges.

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Trial registration This study was registered as a clinical trial to the ClinicalTrials.gov, and the registration ID is NCT06262841 (https://clinicaltrials.gov/study/NCT06262841).

Keywords Piezosurgery, Rotary instruments, Trismus, Edema, Pain, Alveolar bone healing

Introduction

The extraction of impacted lower third molar teeth is a common procedure, with an impaction incidence of approximately 66% [1]. Impacted third molars can lead to various complications, including periodontitis, orthodontic and prosthetic issues, pericoronitis, root resorption, caries in adjacent teeth, pain, infection, and the formation of cysts or tumors [2]. These complications necessitate the removal of impacted teeth, often leading to postoperative challenges.

Traditionally, mandibular third molar extractions are performed using conventional rotary instruments. While effective, these tools are associated with significant postoperative complications such as pain, swelling, trismus, nerve damage, bleeding, and alveolar osteitis. In response to these challenges, piezosurgery has emerged as an alternative surgical technique. Unlike conventional methods, piezosurgery uses ultrasonic micro-vibrations to selectively cut bone tissue, thereby minimizing damage to surrounding soft tissues and reducing the risk of complications.

The piezoelectric effect, first discovered by Pierre and Marie Curie in 1880, laid the foundation for piezosurgical devices, which were later developed in the 1990s by Thomas Vercelotti for use in oral and maxillofacial surgery [3, 4]. Piezosurgery operates at frequencies between 25 to 30 kHz, utilizing nitride-hardened or diamond-coated tips to achieve precise and safe osteotomies. This technique has been shown to reduce the risk of thermal damage and osteonecrosis, promoting faster healing [5–7].

Despite its advantages, the clinical efficacy of piezosurgery compared to conventional rotary instruments remains underexplored, particularly in terms of postoperative outcomes such as pain, trismus, swelling, and bone healing. Previous studies, such as those by Arakji et al. [8] and Cicciù et al. [9], have demonstrated similar outcomes, with piezosurgery showing advantages in reducing postoperative morbidity but requiring longer operation times. The present study aims to address this gap by conducting a randomized, split-mouth trial to compare these outcomes following the surgical extraction of impacted lower third molars using piezosurgery versus conventional rotary instruments.

Materials and methods

Patient selection and study design

This prospective, randomized, split-mouth study was conducted in the Department of Oral and Maxillofacial Surgery at Ankara University Faculty of Dentistry. Ethical approval was obtained from the Scientific Research Ethics Committee (Approval Date: 16.03.2020, Reference Number: 36290600/08). All participants provided informed consent prior to inclusion in the study. This study was registered as a clinical trial to the ClinicalTrials.gov, and the registration ID is NCT06262841 (https://clinicaltrials.gov/study/NCT06262841).

A total of 21 patients (10 men and 11 women) were selected based on specific inclusion and exclusion criteria. None of the 21 patients included in the study dropped out. The patients ranged in age from 18 to 35 years, with a mean age of 25.02 ± 3.38 years. To be included, patients were required to have bilaterally and symmetrically impacted lower third molars, indicated for prophylactic or orthodontic extraction. The difficulty of the surgical extractions was classified as Class 2, Position B according to the Pell–Gregory classification, with all impacted molars in a mesioangular or vertical position according to Winter's classification, as determined by panoramic radiographs.

Inclusion criteria were as follows: patients with no systemic diseases, no pain, swelling, or restrictions in mouth opening, and those with similar surgical extraction difficulties for both impacted teeth. Exclusion criteria included inadequate oral hygiene, periodontal disease, uncooperative behavior, smoking habits, systemic diseases, immunosuppressive drug use, ongoing antibiotic treatment, pregnancy, lactation, substance abuse (including alcohol and drugs), trismus, swelling, pain, and refusal to participate.

Power analysis determined that 42 bilateral teeth were sufficient for the study. This analysis was based on ensuring adequate statistical power to detect significant differences between the two surgical methods. In our study, the sample size was determined based on a power analysis with a power of 90% ($1-\beta = 0.90$) to detect a specified effect size. The analysis was conducted at a significance level of $\alpha = 0.05$.

Surgical technique

The surgical method—either piezoelectric surgery or conventional rotary instruments—used for the extraction of bilaterally impacted teeth was randomly assigned by a coin toss. To standardize the surgical procedure and minimize variability in postoperative outcomes, all operations were performed by the same surgeon (M.K.E.) [10]. The piezoelectric surgery device (NSK-VarioSurg, NSK, Japan) was employed for 21 extractions, while the remaining 21 extractions were conducted using a conventional rotary instrument (Sirona-T1 Line Micromotor, Dentsply Sirona, Germany). To avoid cross-influence of postoperative results, the two surgeries on each patient were spaced four weeks apart.

The surgical area was prepared by cleaning the patients' faces with povidone-iodine, draping them with sterile covers, and rinsing their mouths with a povidone-iodine solution. Local anesthesia was administered via buccal nerve infiltration and inferior alveolar nerve block, using 2 ml of articaine solution (Ultracaine D-S forte, Sanofi Aventis, Germany) containing 0.006 mg epinephrine. A trapezoidal incision was made with a No. 15 scalpel, starting from the anterior edge of the mandibular ramus and extending obliquely toward the buccal region. The incision was completed with an oblique vertical cut in the sulcular gingiva of the second molar, taking care to protect the mesial papilla. Mucoperiosteal flaps were then elevated to expose the crestal bone.

In the conventional method, bone removal was performed using 1.6-mm diameter steel round burs attached to a flat micromotor head operating at 40,000 rpm. Continuous irrigation with sterile saline was applied during the operation to control heat and clear debris from the surgical field.

For the piezosurgery method, appropriate surgical tips were selected, and bone removal along with tooth sectioning was executed using ultrasonic frequencies between 25 and 30 kHz, with microvibration amplitudes ranging from 30 to 60 µm/s. Following bone removal, the teeth were extracted from their alveoli using elevators. Any sharp bone spurs were smoothed using burs and ultrasonic tips, followed by curettage of the extraction socket. The area was irrigated with 30–50 ml of sterile 0.9% saline solution.

After tooth extraction, the flaps were primarily sutured using a 3/0, 20 mm, 1/2 round non-traumatic silk suture. Postoperatively, patients were prescribed Augmentin 625 mg (500 mg amoxicillin + 125 mg clavulanic acid) to be taken twice daily for seven days, along with Parol 500 mg (paracetamol) to be taken three times daily for seven days. Surgical site antisepsis was maintained using chlorhexidine and benzydamine mouthwash, to be used for at least 30 s every 8 h, except on the day of the surgery. Sutures were removed on the 7th postoperative day.

Operation time

The operation time for each surgery, whether performed using piezosurgery or conventional rotary instruments, was recorded using a chronometer. The timing began with the initial incision and ended when the final suture was placed.

Pain

Postoperative pain was assessed using the Visual Analogue Scale (VAS). Patients were instructed to record their pain levels at the 6th, 12th, and 24th hours post-surgery, as well as on the 2nd, 3rd, 4th, 5th, 6th, and 7th days. The VAS scale provided a subjective measurement of pain intensity, with higher scores indicating greater pain.

Mouth opening

The maximum inter-incisal distance was measured with a ruler to evaluate mouth opening. Measurements were taken immediately before the surgery and on the 1st, 3rd, and 7th postoperative days. This assessment helped determine the degree of trismus following the surgical procedures.

Swelling

Swelling was quantified using a method described by Neupert et al. [11]. Measurements were taken between six fixed anatomical points on the operated side of the face while the patient stood upright. A flexible ruler was used to measure the following distances (Fig. 1):

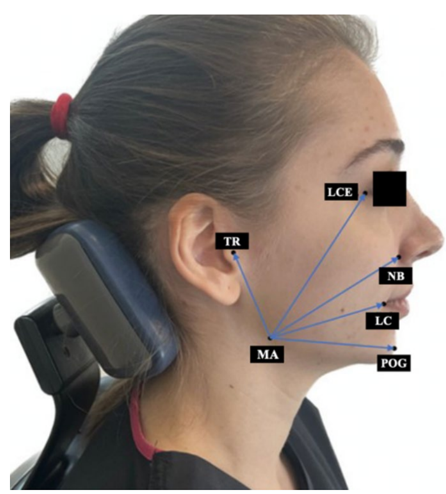

Fig. 1 Swelling measurement points

1. Tragus (TR) to mandibular angle (MA).
2. Lateral canthus of eye (LCE) to mandibular angle (MA).
3. Nasal border (NB) to mandibular angle (MA).
4. Labial commissure (LC) to mandibular angle (MA).
5. Pogonion (POG) to mandibular angle (MA).

These distances were recorded preoperatively and on the 1st, 3rd, and 7th postoperative days to evaluate changes in facial swelling.

Neurological complications

Neurological complications, specifically paresthesia, were assessed at the 24th postoperative hour. Patients were asked whether they experienced numbness in the corners of their lips. The presence or absence of paresthesia was recorded but not included in the statistical analysis.

Alveolar osteitis

Alveolar osteitis was diagnosed based on the presence of a painful, non-suppurating necrotic socket, surrounded by intact gingival tissues, observed 2–5 days post-extraction. These findings were documented as either present or absent and were not included in the statistical analysis.

Alveolar bone healing

Alveolar bone healing was evaluated using orthopantomograms (OPG) taken at the 3rd and 6th months postoperatively. The OPGs were obtained using a Planmeca ProMax device set at 66 kV and 9 mA. The radiographs were digitized and analyzed using Adobe Photoshop CS6. The tooth extraction socket regions were marked using the Magnetic Lasso tool, and grayscale values were examined using the Histogram tool. These grayscale values were used to quantify new bone formation at the 3rd and 6th months, and the results were compared statistically between the two surgical methods (Fig. 2).

To ensure standardization in measuring grayscale values on panoramic radiographs, all images were taken using the same X-ray machine with consistent exposure settings, including kilovoltage, milliamperage, and exposure time. Additionally, patients were positioned in the same manner during image acquisition to maintain uniformity in radiographic projections. The grayscale values were measured in a consistent anatomical region of interest across all images. This standardization process was critical to minimize variability and ensure that the grayscale measurements were reliable and comparable across different radiographs.

Statistical method

Statistical analysis was performed using the dependent groups t-test to compare operation time, swelling, trismus, pain, and alveolar bone healing measurements between the two surgical methods. Confidence intervals were calculated for key outcomes to account for the small sample size.

Results

Operation time

The mean operation time was significantly longer in the piezosurgery group (18.27 ± 4.25 min) compared to the conventional rotary instrument group (11.07 ± 3.61 min) ($p < 0.05$).

Swelling

A statistically significant difference in swelling was observed between the two methods, specifically in the mandibular angle-tragus (MA-TR) measurements on the 1st, 3rd, and 7th postoperative days. Swelling was greater in the conventional group compared to the piezosurgery group ($p < 0.05$) (Table 1).

In the piezosurgery group, the measurements between MA-TR, MA-LCE, MA-NB, MA-LC, and MA-POG significantly increased on the 1st and 3rd postoperative days

Fig. 2 Investigation of grayscale values of extraction sockets in postoperative periods with the Histogram tool in the Adobe Photoshop Program

Table 1 Dependent groups paired t-test table for postoperative conventional and piezosurgery side swelling measurements on the 1st, 3rd and 7th days

Swelling	Conventional X ± sd (cm)	Piezosurgery X ± sd (cm)	*p*
MA-TR Day1	6.50 ± 1.10	6.28 ± 1.10	**0.037**
MA-TR Day3	6.58 ± 1.02	6.28 ± 1.13	**0.008**
MA-TR Day7	6.37 ± 0.99	6.18 ± 1.1	**0.031**
MA-LCE Day1	9.37 ± 0.66	9.58 ± 0.56	0.127
MA-LCE Day3	9.5 ± 0.67	9.62 ± 0.62	0.329
MA-LCE Day7	9.28 ± 0.63	9.42 ± 0.56	0.242
MA-NB Day1	10.1 ± 0.75	10.3 ± 0.76	0.222
MA-NB Day3	10.41 ± 0.68	10.35 ± 0.78	0.508
MA-NB Day7	10.02 ± 0.67	10.02 ± 0.75	0.957
MA-LC Day1	8.41 ± 0.96	8.55 ± 0.78	0.456
MA-LC Day3	8.78 ± 0.87	8.62 ± 0.81	0.300
MA-LC Day7	8.14 ± 0.86	8.15 ± 0.72	0.975
MA-POG Day1	10.39 ± 0.56	10.66 ± 0.73	0.075
MA-POG Day3	10.64 ± 0.63	10.7 ± 0.77	0.646
MA-POG Day7	10.15 ± 0.49	10.21 ± 0.66	0.552

Values in bold indicate statistical significance ($p < 0.05$)

X: mean value, sd: standard deviation

but approached preoperative values by the 7th day, indicating resolution of swelling (Table 2). In contrast, the conventional group showed higher swelling on the 3rd day compared to the 1st and 7th days, with day 7 measurements lower than those on days 1 and 3. Notably, MA-NB measurements were higher on the 3rd day compared to days 1 and 7 in the conventional group, while these measurements remained consistent on days 1 and 7. In the piezosurgery group, all swelling measurements significantly decreased by the 7th day compared to days 1 and 3, with consistent measurements between days 1 and 3. Across both methods, MA-TR, MA-LCE, MA-NB, MA-LC, and MA-POG measurements were significantly higher on days 1, 3, and 7 compared to preoperative values (Table 2).

Mouth opening

Mouth opening was significantly greater in the piezosurgery group on the 1st, 3rd, and 7th postoperative days compared to the conventional group ($p < 0.05$) (Table 3).

In the piezosurgery group, mouth opening was significantly reduced on the 1st and 3rd days compared to preoperative measurements but returned to preoperative levels by the 7th day. In the conventional group, mouth opening remained significantly lower than preoperative measurements on the 1st, 3rd, and 7th days (Table 4).

Pain

VAS pain measurements revealed statistically significant differences between the two methods at the 6th, 12th, and 24th hours, as well as on the 2nd, 3rd, and 4th postoperative days. Pain levels were higher in the conventional group during these periods. However, no significant differences in pain were observed between the

Table 3 Dependent groups paired t-test table for postoperative conventional and piezosurgery side mouth opening measurements on the 1st, 3rd and 7th days

Mouth opening	Conventional X ± sd (mm)	Piezosurgery X ± sd (mm)	*p*
Day1	29.10 ± 7.50	33.24 ± 5.95	**0.006**
Day3	33.43 ± 7.88	37.33 ± 5.32	**0.006**
Day7	37.19 ± 7.51	41.95 ± 5.19	**0.002**

Values in bold indicate statistical significance ($p < 0.05$)

Table 2 Comparison of swelling measurements in conventional and piezosurgery methods preoperatively and on the 1st, 3rd and 7th days after the operation

Technique measurement	Preoperative X ± sd (cm)	Postoperative (Day 1) X ± sd(cm)	*p*	Postoperative (Day 3) X ± sd(cm)	*p***	Postoperative (Day 7) X ± sd(cm)	*p****
MA-TR	6.30 ± 0.98	6.50 ± 1.10	**0.000**	6.58 ± 1.02	**0.000**	6.37 ± 0.99	**0.012**
MA-LC	9.20 ± 0.64	9.37 ± 0.66	**0.000**	9.50 ± 0.67	**0.000**	9.28 ± 0.63	**0.007**
MA-NB	9.79 ± 0.71	10.10 ± 0.75	**0.000**	10.41 ± 0.68	**0.000**	10.02 ± 0.67	**0.000**
MA-LC	7.80 ± 0.91	8.41 ± 0.96	**0.000**	8.78 ± 0.87	**0.000**	8.14 ± 0.86	**0.000**
MA-POG	9.89 ± 0.50	10.39 ± 0.56	**0.000**	10.64 ± 0.63	**0.000**	10.15 ± 0.49	**0.000**
MA-TR	6.18 ± 1.10	6.28 ± 1.10	**0.000**	6.28 ± 1.13	**0.002**	6.18 ± 1.1	1.000
MA-LC	9.42 ± 0.54	9.58 ± 0.56	**0.000**	9.62 ± 0.62	**0.000**	9.42 ± 0.56	0.666
MA-NB	10.01 ± 0.76	10.3 ± 0.76	**0.000**	10.35 ± 0.78	**0.000**	10.02 ± 0.75	0.186
MA-LC	8.13 ± 0.73	8.55 ± 0.78	**0.000**	8.62 ± 0.81	**0.000**	8.15 ± 0.72	0.083
MA-POG	10.21 ± 0.68	10.66 ± 0.73	**0.000**	10.70 ± 0.77	**0.000**	10.21 ± 0.66	0.733

Values in bold indicate statistical significance ($p < 0.05$)

Table 4 Comparison of the mouth opening measurements in conventional and piezosurgery methods preoperatively and on the 1st, 3rd and 7th days postoperatively

Group measurement	Preoperative X ± ss (mm)	Postoperative (Day1) X ± sd (mm)	p*	Postoperative (Day3) X ± sd (mm)	p**	Postoperative (Day7) X ± sd (mm)	p***
Mouth Opening	40.33 ± 5.83	29.10 ± 7.5	**0.000**	33.43 ± 7.88	**0.000**	37.19 ± 7.51	**0.013**
Mouth Opening	42.43 ± 5.52	33.24 ± 5.95	**0.000**	37.33 ± 5.32	**0.000**	41.95 ± 5.19	0.056

Values in bold indicate statistical significance ($p < 0.05$)

Table 5 Dependent groups t test table for postoperative VAS pain measurements for conventional and piezosurgery methods

Measurement (VAS)	Conventional X ± sd	Piezosurgery X ± sd	p
6th hour	5.33 ± 1.12	3.54 ± 0.94	**0.000**
12th hour	3.67 ± 1.42	2.83 ± 0.7	**0.022**
24th hour	2.76 ± 1.38	1.88 ± 0.95	**0.013**
2nd day	1.95 ± 1.6	1.24 ± 0.7	**0.040**
3rd day	1.45 ± 1.47	0.57 ± 0.68	**0.012**
4th day	0.62 ± 1.12	0.10 ± 0.30	**0.030**
5th day	0.38 ± 1.20	0 ± 0	0.162
6th day	0.38 ± 1.02	0 ± 0	0.104
7th day	0 ± 0	0 ± 0	0

Values in bold indicate statistical significance ($p < 0.05$)

Table 6 Dependent groups t test table for histogram 3rd and 6th month measurements on the sides using piezosurgery and conventional methods

Histogram	Piezosurgery	Conventional	p
3rd month	143.26 ± 4.55	141 ± 5.3	**0.002**
6th month	163.48 ± 4.65	162.85 ± 4.42	**0.011**

Values in bold indicate statistical significance ($p < 0.05$)

groups on the 5th, 6th, and 7th days ($p > 0.05$). This indicates that pain was significantly lower in the piezosurgery group during the first four postoperative days (Table 5).

In the conventional group, pain levels gradually decreased starting from the 6th hour postoperatively, with no significant changes after the 4th day. Similarly, in the piezosurgery group, pain levels decreased gradually from the 6th hour, with no significant reduction between the 6th and 12th hours or after the 4th day.

Alveolar bone healing

The histogram measurements used to assess alveolar bone healing showed statistically significant differences between the two methods at the 3rd and 6th months postoperatively. Although the numerical differences were not large, new bone formation was significantly higher in the piezosurgery group at both time points ($p < 0.05$) (Table 6). Additionally, for both methods, bone formation significantly increased from the 3rd to the 6th month.

Neurological complications

Paresthesia, a possible complication due to inferior alveolar nerve damage following the extraction of impacted lower third molars, occurred in one patient from the conventional group. The patient experienced full recovery by the 4th week postoperatively.

Alveolar osteitis

No cases of alveolar osteitis were observed in the areas where either piezosurgery or conventional methods were applied.

Discussion

This split-mouth, randomized clinical trial compared the postoperative outcomes of piezosurgery and conventional rotary instruments in the extraction of impacted lower third molars. The study utilized standardized surgical protocols and measurement methods to evaluate operation time, postoperative pain, trismus, swelling, neurological complications, alveolar osteitis, and alveolar bone healing. The split-mouth design was chosen to minimize the impact of individual patient differences on postoperative outcomes, making it ideal for comparative studies [12].

The severity of postoperative complications, such as pain, swelling, and trismus, can be influenced by the patient's overall health and age [13]. In this study, systemically healthy young adults aged 18 to 35 years were selected, and all surgical procedures were performed by the same experienced surgeon. This standardization aimed to reduce variability and ensure that observed differences in outcomes were attributable to the surgical techniques rather than external factors [14, 15].

While piezosurgery resulted in a longer operation time, it demonstrated quicker recovery and fewer postoperative complications compared to the conventional method. Operation time can vary based on several factors, including the surgeon's experience, the complexity of the extraction, and the patient's age. However, the same surgeon performed all extractions on symmetrical, bilaterally impacted teeth, reducing these variables. This finding aligns with Mantovani et al. [16], who reported minimal differences in operation time when comparing surgeons with five years of piezosurgery experience.

One of the significant advantages of piezoelectric surgery in oral and maxillofacial surgery (OMFS) is its ability to minimize the risk of nerve injury. The selective cutting action of piezoelectric devices allows for precise osteotomy while sparing nerves and soft tissues, a crucial factor in complex procedures such as genioplasty [17]. This selectivity is due to the ultrasonic vibrations that effectively cut mineralized tissue while having minimal impact on soft tissues, thereby reducing the risk of iatrogenic nerve damage. The superior control and precision offered by piezoelectric instruments allow surgeons to perform delicate procedures with greater confidence, especially in anatomically challenging areas where the risk of nerve injury is high.

Furthermore, piezoelectric surgery demonstrates improved soft tissue preservation, which is particularly beneficial in various OMFS procedures. Toscano et al. [18] reported a lower incidence of membrane perforations in open sinus lift procedures when using piezoelectric devices compared to traditional rotary instruments. This enhanced soft tissue management not only reduces the risk of complications, but also potentially improves postoperative healing and patient outcomes.

Postoperative pain, as measured by the Visual Analogue Scale (VAS), was significantly higher in the conventional group from the 6th hour to the 4th postoperative day. However, from the 5th day onward, pain levels between the two groups were comparable. These results are consistent with findings from Mantovani et al. [16] and Barone et al. [19], who also observed lower pain levels with piezosurgery despite its longer operation time. Interestingly, Rullo et al. [20] noted that while piezosurgery reduced pain in simple extractions, it was associated with higher pain levels in complex cases due to prolonged operation time and the associated release of pain mediators. Nonetheless, piezosurgery remains a safe technique, particularly effective in reducing postoperative morbidity and preserving anatomical structures in less complex extractions.

The subjective nature of pain, influenced by factors such as patient pain tolerance and expectations, contributes to the variability in reported outcomes. This complexity makes pain more challenging to evaluate objectively compared to other variables like trismus and swelling, which are more straightforward to measure. Future studies should consider incorporating more standardized pain assessment methods or exploring additional factors that might influence pain perception.

Regarding swelling, our study found that the piezosurgery group exhibited less swelling, particularly in the mandibular angle-tragus (MA-TR) measurements on the 1st, 3rd, and 7th days postoperatively. This observation is in line with Bhati et al. [21], who reported that swelling in the piezosurgery group returned to preoperative levels by the 7th day. Similarly, Sortino et al. [22] and Piersanti et al. [23] observed reduced postoperative swelling with piezosurgery compared to conventional methods. These findings further support the clinical benefits of piezosurgery in minimizing postoperative edema.

Mouth opening measurements, a proxy for trismus, were significantly greater in the piezosurgery group on the 1st, 3rd, and 7th postoperative days. Both methods showed a significant increase in mouth opening from the 1st to the 7th day, which is consistent with the findings of Jiang et al. [24], who reported less trismus in piezosurgery groups.

Alveolar bone healing, assessed via histogram measurements at the 3rd and 6th months postoperatively, was significantly better in the piezosurgery group. Arakji et al. [8] also found that new bone formation was higher in the piezosurgery group at these intervals. This enhanced bone healing is likely due to the precise and controlled bone cutting afforded by piezosurgery, which minimizes trauma to surrounding tissues [7]. Histological studies [3, 25] confirm piezosurgery's ability to cut bone with minimal disruption to surrounding vasculature, while biomolecular research [26–28] highlights its effectiveness in reducing postoperative inflammation and oxidative stress. These factors collectively contribute to faster recovery, reduced morbidity, and improved quality of life for patients undergoing impacted third molar extractions [28–31].

The superiority of piezoelectric surgery in OMFS lies in its ability to selectively cut mineralized tissue while sparing soft tissues. This characteristic results in a significantly lower risk of nerve injury and optimal soft tissue preservation. The ultrasonic vibrations of piezoelectric devices allow for precise osteotomy with minimal damage to adjacent structures, making it particularly valuable in procedures involving delicate anatomical areas. This enhanced safety profile, combined with the potential for reduced postoperative complications, positions piezoelectric surgery as a preferred technique for many oral and maxillofacial procedures, especially those in proximity to critical neurovascular structures.

Despite its advantages, piezosurgery has challenges, including rapid tip wear on enamel tissue, leading to increased costs and longer operation times [9]. Additionally, the variability in measurement techniques across studies presents a challenge in conducting comprehensive meta-analyses, particularly regarding swelling outcomes. Furthermore, non-standardized impaction classifications across different studies can contribute to variability in reported outcomes. Standardizing these classifications could help in more accurately comparing results across studies.

This study, while providing valuable insights, has limitations, including a relatively small sample size of 42 tooth regions, as determined by power analysis. To achieve more precise and statistically robust conclusions, larger studies are necessary. Additionally, the development and adoption of standardized protocols for measuring postoperative complications would enhance the reliability of comparisons across studies and facilitate more comprehensive meta-analyses.

The assessment of postoperative bone healing remains limited, with few studies exploring this outcome. Future research could benefit from using advanced imaging techniques, such as 3D software, to provide more detailed and accurate evaluations of bone regeneration. Larger-scale studies are also needed to compare postoperative complications between piezosurgery and conventional rotary instruments more thoroughly.

Conclusion

Despite these limitations, the findings of this study suggest that piezosurgery offers significant advantages in reducing postoperative pain, trismus, and swelling, while also minimizing the risk of nerve injury and preserving soft tissue integrity. These benefits can contribute to an overall improvement in the post-surgical quality of life for patients undergoing the extraction of impacted lower third molars and other complex oral and maxillofacial procedures.

Authors contribution

Concept/Design: M.K.E. and M.C. Data analysis/interpretation: M.K.E. and M.C. Drafting article: M.K.E. Critical revision of the article: M.K.E. and M.C. Approval of article: M.K.E. Statistics: M.K.E. Data collection: M.K.E. All authors reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Ethical approval for this prospective study was obtained from the Ankara University Faculty of Dentistry Clinical Research Ethics Committee and in accordance with the 1964 Declaration of Helsinki and its subsequent changes or similar ethical standards (Reference Number: 36290600/08).

Patient consent

Written informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare no competing interests.

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